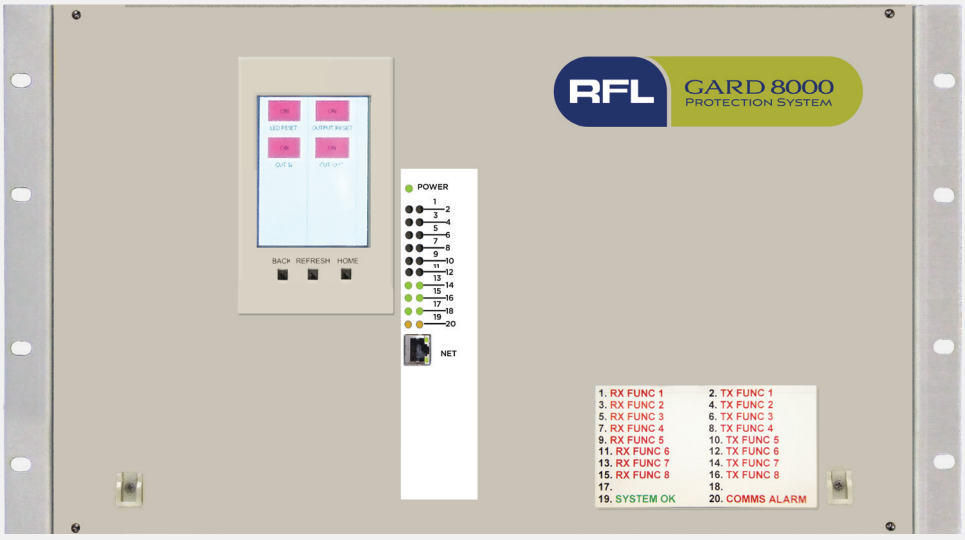
SOLUTIONS FOR AN EVOLVING WORLD

RFL GARD 8000

Protective Relay & Communications System



Your world is changing and so are we.

At RFL, we know your needs change much faster than your infrastructure. Our comprehensive line of solutions meets you wherever you are to help you bridge the gap from yesterday to tomorrow.

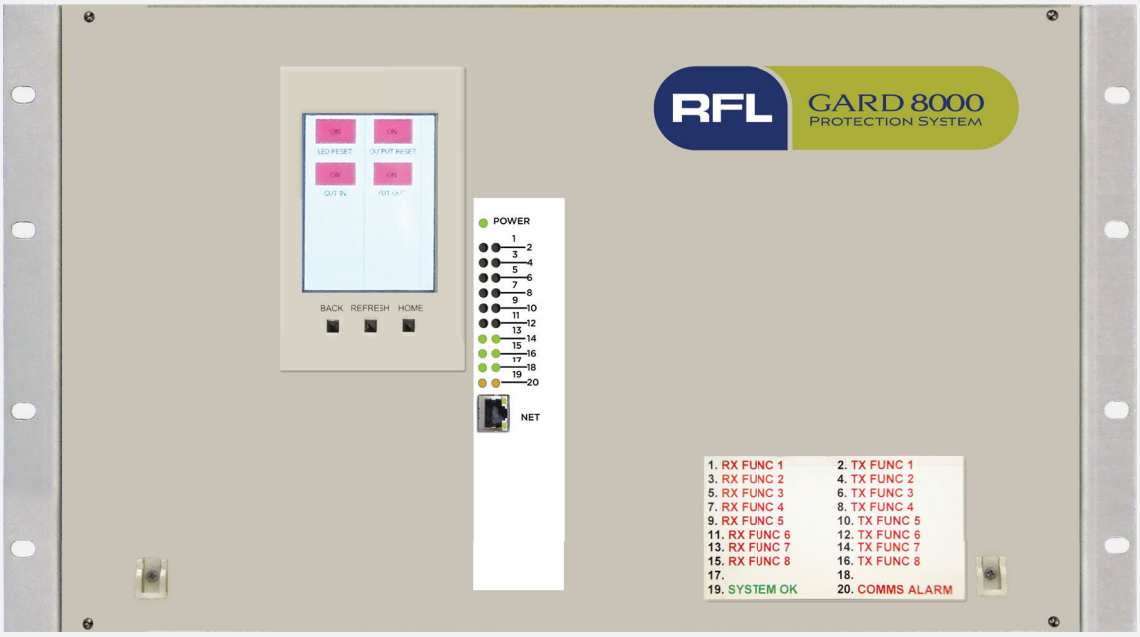
We aren't just engineering products. We are continuously innovating to give legacy equipment the advantage of today's technologies. Our highly adaptable solutions offer more features for more flexibility and a custom fit for your specific needs.

When we deliver, we also deliver our reputation. So when you open that box, you're opening a custom-engineered solution, factory-tested and ready for deployment.

And as long as you own that equipment, you own the attention of RFL. We see you as our partner and we want to ensure that our solution is working for you – now and over the long haul. RFL – delivering solutions that work. Period.

GARD 8000

Protective Relay & Communications System



System Features

One product for all your teleprotection and line protection needs

Proven, high-speed, secure and reliable synchronous communications

Use as a stand-alone Teleprotection Channel, Current Differential Protection, Distance Protection, Power Line Carrier, or combine them in one device

Selectable redundancy for power supply, main processor, functional modules and communication interfaces

Customized programmable logic for your specific application saves commissioning time and eliminates complex configuration

Straight-forward web browser user interface for settings and diagnostics; no proprietary application program required

Optional, built-in GPS receiver provides accurate time tags, independently from any station clock

Supports NERC/FERC security standards

Efficient use of your communications channel; up to 12 x 64 kbps per communication interface

Metering, Telemetry and Status Modules for RAS (Remedial Action Scheme) Wide Area Protection

A wide range of communication interfaces to choose from:

- T1/E1
- RS-449, 56 -768 kbps
- X.21, 64-768 kbps
- V.35, 64-768 kbps
- G.703, co-directional, 64 kbps
- ANSI C37.94 fiber
- Fiber, multi-mode or single-mode; up to 100 km
- Audio Tone, 2 wire or 4 wire
- Power Line Carrier; ON/OFF or FSK selectable

GARD 8000 supports DNP3 Level 2 with point mapping

Supports IEC 61850

10 Year Warranty

System Specifications

System Description

The GARD 8000 Global Architecture Relaying Device is a revolutionary product platform that provides the user with a fully programmable system that can be used for all teleprotection and line protection needs.

The system uses fully programmable logic and settings that can be uploaded or downloaded using the built-in TCP/IP (electrical or optical) or RS-232 interface. Communicating with the system is done with a PC using a Web Browser. The GARD 8000 has a built-in web server that contains all of the user settings, no special or proprietary software is required to access the product. A most unique feature is that the user manual and customer system and application drawings are stored in the GARD 8000 in Adobe pdf format and are easily accessible from the GARD 8000 web browser.

The GARD 8000 is available in a 3U chassis (5.25") which can support up to two additional teleprotection or protective relay function modules, or a 6U chassis (10.50") which
can support up to eight teleprotection or protective relay function modules. Redundant controller and power supplies are available as options for applications where ultra reliable systems are required.

Protection System

Proper performance of the Protection System requires a functioning communication link and teleprotection device. While protective relays are commonly duplicated for increased redundancy, this is not always the case for the communications channel. Limited availability of external communication links, or the cost of adding a second channel compromises power system protection redundancy.

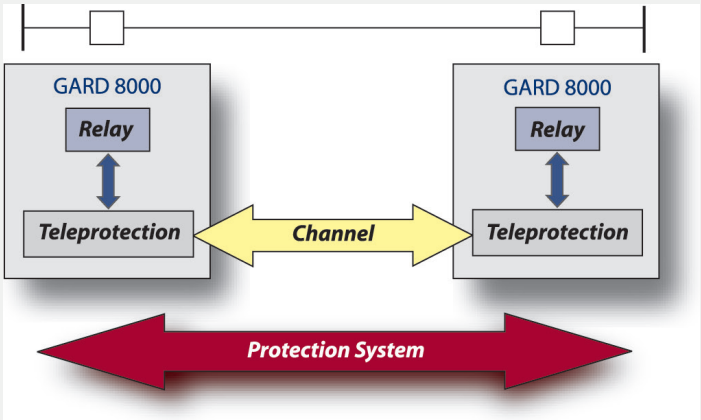


Figure 1. Protection System

System protection redundancy can be improved by the GARD 8000 System. Not only can additional channels easily be made available but the built-in hardware redundancy will provide a higher degree of dependability than two separate protection systems. In addition, external relay-to-teleprotection wiring is eliminated, minimizing the risk of faulty connections or interference affecting the protection system.

Hardware Redundancy

The telecommunications industry has very stringent requirements for redundancy. The principle of "no single point of failure" is adopted. With the increased demands on the power system, hardware redundancy in the protection device provides an added level of insurance. The GARD 8000 can be equipped with redundant power supplies, redundant main processors, redundant input/outputs, redundant functional modules and redundant communication interfaces providing an unequaled safe-guard against equipment failures.

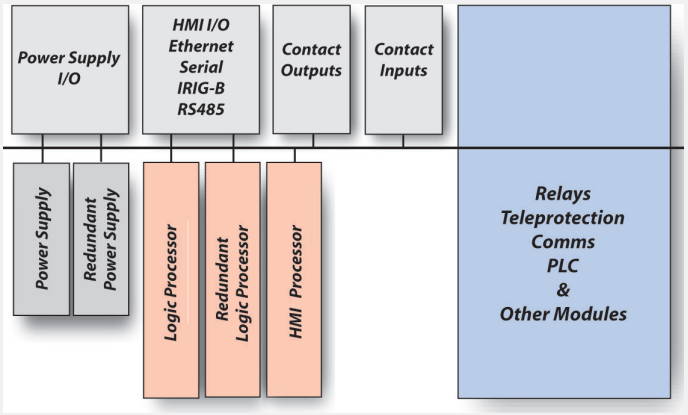


Figure 2. Hardware Redundancy

Economical Use of Your Communication Link

With the exponential growth of data communications, the use of a dedicated fiber for a single channel, low-speed data, might no longer be justified. The GARD 8000 system uses the communication channel efficiently and can provide up to 768 kbps on one link (twelve 64 kbps channels).

The GARD 8000 System offers interfaces for dedicated fiber and direct connection to T1/E1 or SONET/SDH muliplexers.

For applications where no digital channels are available, the audio tone interfaces can be used for 2-wire or 4-wire FSK communications. In addition, GARD 8000 can be equipped with an integral Power Line

System Specifications (continued)

The GARD 8000 System provides 24 channels, each carrying 64 kbps data. These channels can be assigned to any communications interface and operate redundantly or independently

Functional Redundancy

It has been shown that redundancy is increased by built-in redundant modules, operating in parallel. A typical, coven-tional, protection system would consist of a Main 1 pilot protection scheme and a Main 2 pilot or non-pilot scheme.

The GARD 8000 offers full flexibility to use multiple communication interfaces for Main and Redundant relay protections. Both protections can communicate over both channels or they can use separate channels.

You may also achieve redundancy by using one interface with multiple channels when digital media is available, or use one digital communications interface for more data demanding protections such as current differential and a second, independent, analog channel for distance pilot and/or transfer trip functions.

Optimize Existing Fiber Applications

Dedicated fiber links can be routed via the GARD 8000 System making up to twelve 64 kbps channels available on the existing optical fiber. These channels can be used for proven, secure and dependable transfer trip as well as high speed pilot communications, current differential and/or distance protections.
No change to the existing scheme is required.

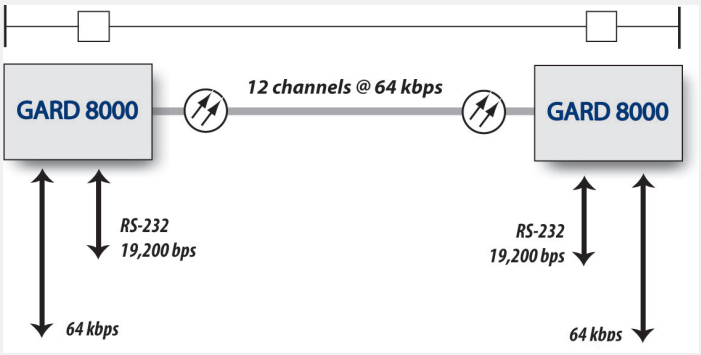


Figure 3. Dedicated Fiber Application

A protection relay using low-speed RS-232 communication or current differential relays using 64 kbps will still have the use of a functionally dedicated point-to-point connection.

Multiplexer Pass-Through Channel

The GARD 8000 has 24 built in communications channels (12 in each of the two subsystems) that can be used for Teleprotection and other Protection applications. These communications channels can also be used with external devices that require a communications or pilot channel to operate. This allows the GARD 8000 Teleprotection channel to also be used as a substation multiplexer that other protective relays can be interfaced with.

The GARD 8000 can be configured with 56/64kb channels with RS-449, G.703, V.35, X.21 and C37.94 fiber optic interfaces. The unit can also be configured with a dual RS-232 communi-cations channel for slow speed devices. Figure 4 shows a RFL 9300 current differential relay and a relay with RS-232 port relay communicating over a GARD 8000 Teleprotection channel configured with two relaying communication interfaces.

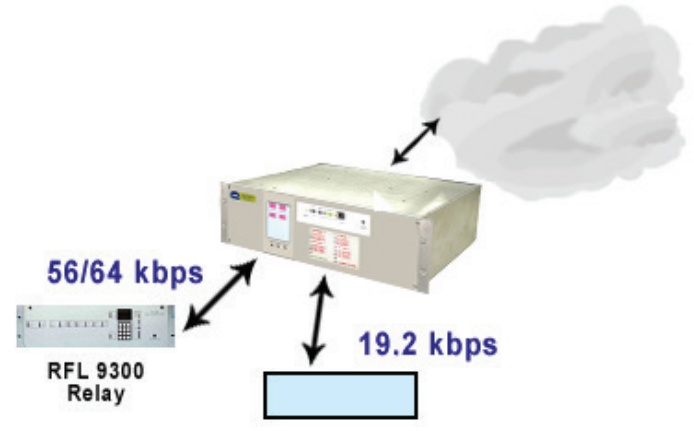


Figure 4. GARD 8000 Used as Multiplexer

The GARD 8000 System can pass the data from one channel on one communications interface directly to another channel on another communications interface. The maximum through-delay for this operation is less than 0.25 ms. Data communication remains synchronous during the pass-through process and can be used for current differential relay channels and teleprotection channels as well as other relaying channels.

System Specifications (continued)

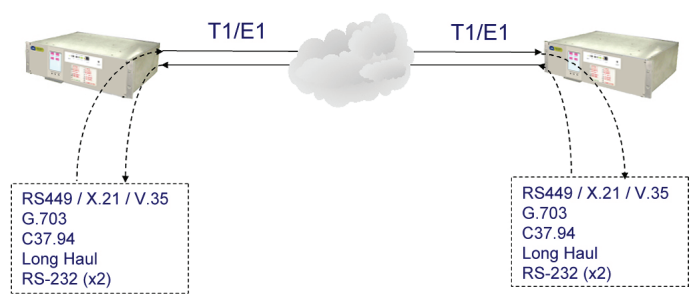


Figure 5. Pass-through functionality

Any GARD 8000 with T1/E1 interface also provides Drop and Insert capability. As illustrated in Figure 6, data can be passed by an external device in station A' to A, or to B'. In the same way data is passed from station B' to B or A'. This functionality, borrowed from multiplexer technology, provides substantial cost savings in applications where a full-blown multiplexer would not be fully utilized.

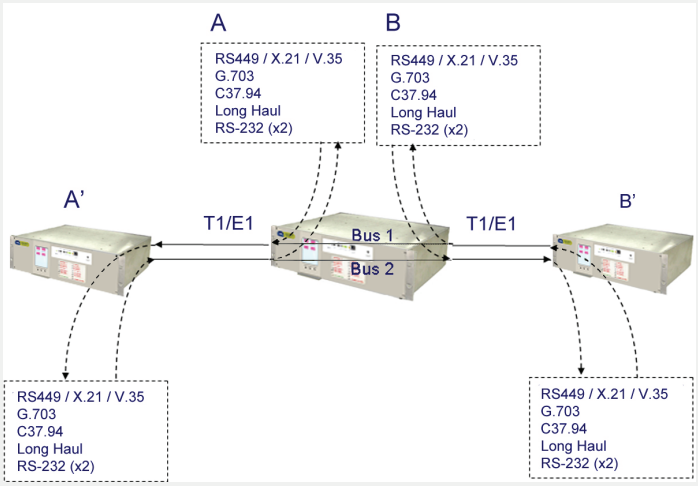


Figure 6. T1/E1 Drop and Insert Capability

Architecture

The GARD 8000 system can be equipped with up to eight functional modules in the 6U chassis and three in the 3U chassis.

- Full featured teleprotection channel
- High speed current differential line protection, charge comparison
- High speed pilot or stepped distance protection
- ON/OFF and FSK Power Line Carrier
- Breaker module for dual breaker applications
- Metering and Telemetry Modules
- Remedial action schemes

All modules independently provide full functionality and can be freely combined to suit your application.

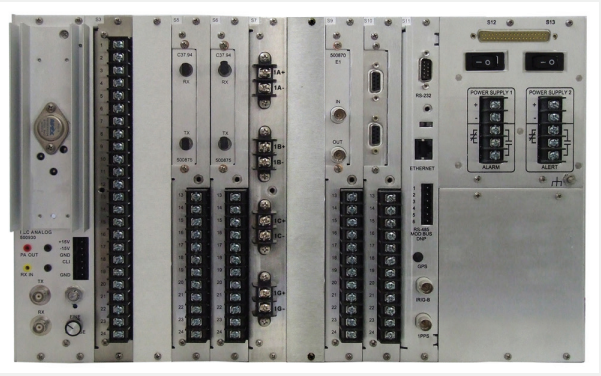


Figure 7. 6U Rear View (Distance configuration)

A Truly Modular System

The GARD 8000 is a modular system and functional modules can be added at any time as needed. This facilitates gradual refurbishment. For instance, the teleprotection channel device can be replaced with GARD 8000 using existing relays for pilot protection. At some later time a protection module can be added to replace or complement the existing relays. Or, communications modules can be added as more external channels become available.

The functional modules are truly individual devices. They all need access to the power supply and the HMI/main processor modules but there is no direct communication between functional modules. This makes it easy to change the functionality of the GARD 8000 as required without having to change the entire system.

Any of the functional modules can be removed at any time (even without powering off the system) without affecting the other functional modules.

A functional module can be located anywhere within a chassis, with the exception of the 3 fixed slots required for the HMI/main processor boards. In this way, a system can contain any combination of functions, with selectable redundancy.

Input and output boards are also freely selectable, and an additional board is easily installed in the field if extra contacts are required.

The modular flexibility extends to the communications modules that may be selected to operate independently or redundantly.

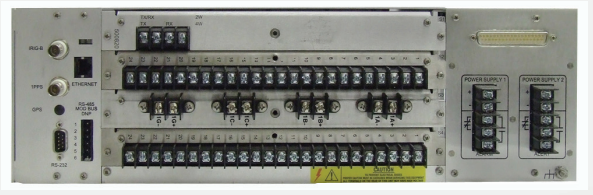


Figure 8. 3U Rear View (Distance configuration)

System Specifications (continued)

User Interface

Protection system reliability may be compromised by increased complexity of protection devices. While these protection devices offer added flexibility they also increase the risk for errors. Complicated settings, configurations and interconnections all combine to having an undesirable effect on protection system security and dependability.

The GARD 8000 System is designed with ease-of-use in mind. While high functionality and great detail is provided, it is not necessary to make field configurations, if not desired. The web browser User Interface makes interaction with the device highly intuitive and handling greatly simplified.

Front Panel LEDs

Two rows of ten multi-colored LEDs provides basic event information. The LED operation is fully configurable and labels can be changed to suit the application. Custom configuration and labeling can be factory-made by RFL without extra charge. Any field modifications required are simply made by use of the browser interface.

Front Panel Display

An optional touch screen display (TSD) is available for metering, targets and settings. The TSD provides a color screen that will automatically orientate itself for horizontal or verticle mounting. User programmable buttons are provided for unique customer requirements. For things such as breaker control or cut-in/cut-out switches.

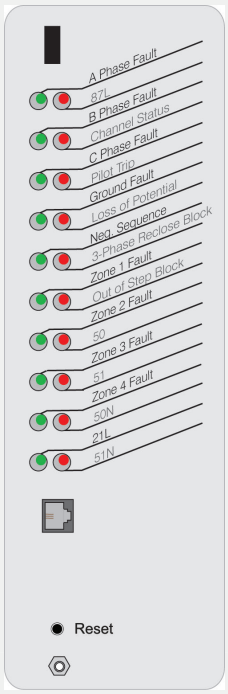


Figure 9. GARD 8000 Front Panel LEDs (6U)

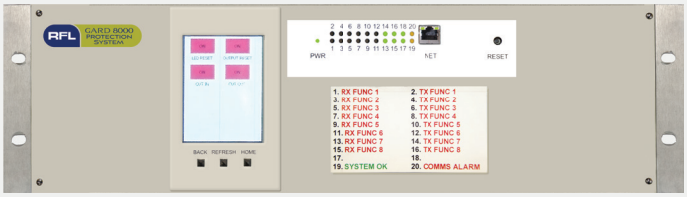


Figure 10. GARD 8000 3U Front Panel

Web Browser User Interface

All interaction with the GARD 8000 System is made by the use of a standard web browser. The web server reside in the device; no special application software is required on the PC.

A PC is connected to the front TCP/IP port with a standard RJ45 connector. Alternatively, the rear RS-232 port can be used but will not provide the same “lightning-fast” response.

Web browser technology provides a much higher level of ease-of-use as compared to the conventional “menu-driven” operation. It is fast and simple to view device status, access diagnostic and test functions and to change settings. With the same operations as a standard web site, navigation is intuitive and eliminates the need to study written instructions. If needed, the instruction manual, that also resides in the device, is simply accessed by the HELP function.

For off-line preparation of settings and configuration files, a small application program “emulating” a GARD 8000 System can reside on the PC or local server. Archiving and documentation of settings and configuration is made simple as these are stored in standard text files.

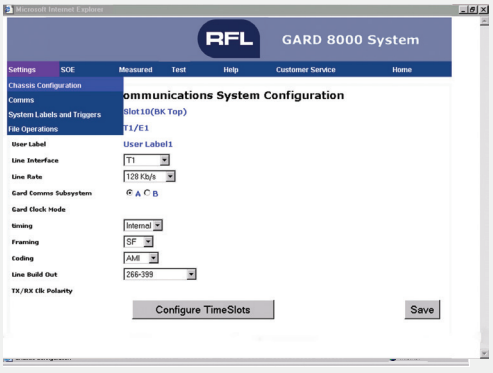


Figure 11. Web Browser User Interface

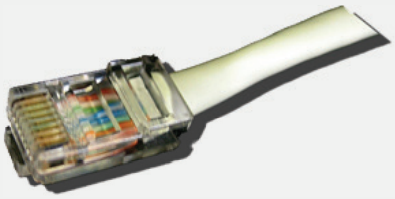


Figure 12. Ethernet Connector

Input and Output Modules

The GARD 8000 System is configured with a selectable number of input and output modules on the rear part of the chassis.

Each communication interface comes with 1 input module with 6 opto-isolated inputs or 1 output module with 6 outputs. Additional solid-state outputs, relay outputs and inputs are mounted in sets of 6, with 2 sets on each board occupying 1 slot. The following combinations are available for mounting in the up to 10 rear slots (6U) or 4 rear slots (3U):

- 1 communication interface/6 inputs
- 1 communication interface/6 outputs
- 6 inputs/6 inputs
- 6 inputs/6 relay outputs
- 6 inputs/6 solid state outputs
- 6 solid state outputs/6 solid state outputs
- 6 solid state outputs/6 relay outputs
- 6 relay outputs/6 relay outputs
- 4 latching relay outputs/4 form C contacts

All relay output contacts are Form A (NO) or Form B (NC) jumper selectable. *With the exception of the latching relays module which is form-C only.

The GARD 8000 Power Supply is provided with Form C alarm contacts for power supply failure and system failure alarm.

Optically Isolated Inputs

Quantity: 6 per module
Input Voltage Jumper Selectable: 24/48/125/250 Vdc
Operation Range:
24 Volts: 19 to 36 Vdc
48 Volts: 37 to 68 Vdc
125 Volts: 94 to 150 Vdc
250 Volts: 189 to 300 Vdc
Input Current: 1.5 mA minimum
Minimum Pulse Width: 0.03 ms, additional debounce time set in the logic

Solid-State Outputs

Quantity: 6 per module
Output Current: Maximum 1 A continuous, 2 A for 1 minute, or 10 A for 100 msec
Open-Circuit Voltage: 300 Vdc maximum
Pick-up Time: 0 msec

Relay Output

Quantity: 6 per module
Relay Pick-up Time: 4 msec
Output Current Rating: 6 A continuous
Surge: 30 A for 200 msec

Alarm Relays

Quantity: 2
Contacts: SPDT (Form C)
Output Current: 100 mA 300 Vdc resistive load

Terminal Connections

Screw terminals for ring lugs with wire up to AWG #10.

GPS Module

Accurate time stamping is essential for evaluation of protection system operations, especially following a major system disturbance.

The substation may be equipped with a GPS central clock that can be connected to the GARD 8000 IRIG-B port. When a central clock is not available the GARD 8000 can have its own, built-in GPS receiver. This module is supplied with a small antenna to be mounted outside to receive the GPS signal.

When the GARD 8000 is equipped with the internal GPS receiver, the IRIG-B port can be used to supply IRIG-B to other devices. This enables not only the GARD 8000 System to keep accurate time tags but other protective devices also have access to a dc-powered, substation hardened, time source that is independent from any centralized GPS system.

Figure 13. GPS Antenna

Protection

Teleprotection System

Based on the RFL 9745 teleprotection channel, the GARD 8000 Teleprotection System carries relaying communications to the next level.

The Teleprotection System is emulating RFL 9745's flexible, customized programmable logic, but provides a higher degree of ease-of-use. Selection of pre-programmed schemes for blocking, unblocking, permissive, and transfer trip operations is simply done by a setting.

The GARD 8000 System is customized to provide the number of channels, type and number of channel interfaces, inputs and outputs and redundancy to meet your application needs. Features include:

- Pre-configured permissive, blocking, unblocking and transfer trip scemes
- 8 to 32 commands per digital interface
- Operating time is 5 ms for digital channel and from 9 ms for analog channel
- 2 or 4 commands per analog channel interface
- Redundant (hot/standby) operation with digital/analog or digital/digital channel interfaces
- Optional 16 point bi-directional status & teleprotection

For applications where a high number of status points need to be transferred, a 96 bit version of the Teleprote tion system module is available. This version allows 96 functions to be transported in one 64 kbps channel slot.

Distance Protection

The distance protection module in the GARD 8000 System has 4 measuring zones, each configurable to forward or reverse operation.

The distance protection can operate as stepped distance with instantaneous operation from Zone 1 with Zone 2 and Zone 3 time-delayed. It can alternatively be applied in a pilot scheme, selectable to permissive, unblocking or blocking.

It may use the same communications channel interface as the current differential relay and/or teleprotection system, or a separate communications interface. Features include:

- 4 Zones, all reversible
- Phase-phase and phase-ground mho
- Selectable quadrilateral characteristic
- POTT, DCUB or DCB pilot schemes
- High-set and inverse time overcurrent elements
- Breaker failure protection
- Reclosing and sync check
- Under- and overvoltage elements
- Frequency elements
- Accurate Fault Locator
- Digital fault records directly in COMTRADE format
- Optional single pole trip logic

The Distance Protection module in the GARD 8000 System can provide back-up for the current differential protection, in case of channel failure. It can also operate in parallel with the current differential providing an independent different measuring principle. Or, it can be used as a stand-alone non-pilot or pilot distance protection.

Current Differential Protection

A current differential protection module can be integrated in the GARD 8000 System. Using one 64 kbps channel, the current differential relay can use the same communication link as the teleprotection system module, or it can have its separate channel interface. Duplicating the highly successful RFL 9300 measuring principle with its high speed operation, the GARD 8000 current differential protection provides added flexibility and enhanced functionality:

- Extended fault recording and oscillography with larger dynamic range and more digital signals
- Fault records directly in COMTRADE allows evaluation by use of any standard reader
- While still extremely simple to set, extended setting ranges are made available for increased system fault current coordination
- Transient block logic for added security at external fault clearing with ct errors
- Adjusts for different ct ratios by setting
- High speed trip; ½ cycle minimum, 1 cycle typical
- Is completely unaffected by channel delay errors up to +/- 4 ms, as may be caused by asymmetric transmit and receive channels
- Two- or three-terminal versions
- Hot/stand-by redundant channel operation
- Optional single pole trip logic
- Dual breaker version

Protection (continued)

Dual Breaker Applications

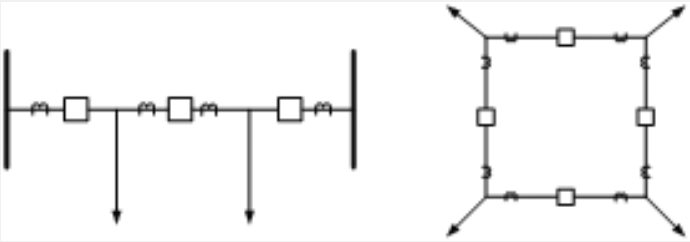


Figure 14. Breaker and a half and Ring Bus Application

A distance line protection operates on the total line current, summed from two ct's in breaker and a half or ring bus applications. However, the breaker failure relay and other breaker related protection elements need to use the individual current inputs from the current transformers.

The GARD 8000 System therefore complements the distance line protection with independent Breaker Modules for these additional functions. The Breaker Module includes breaker failure relay, recloser and sync check, overcurrent, voltage and frequency elements.

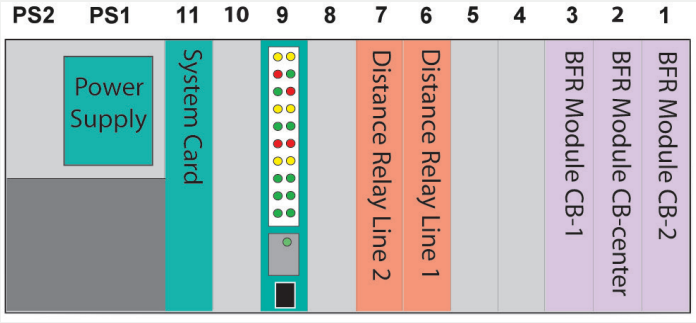


Figure 15. GARD 8000 Distance Protection for a Breaker and a half application

The GARD 8000 System logic makes it easy to combine the protection modules as required by the application. No external interconnection wiring is required as all coordination is performed in the system logic.

For a breaker and a half application, a GARD 8000 System can include two Distance relays, one for each line, and three independent Breaker modules, one for each breaker.

Power Line Carrier

The Power Line Carrier (PLC) module in the GARD 8000 System implements the functionality of the RFL 9785 ON/OFF PLC and the RFL 9780 FSK PLC, all in one device. FSK or ON/OFF operation is selectable and the DSP based transmitter and receiver allows full frequency programmability in the range 30 to 500 kHz.

The setting options include:

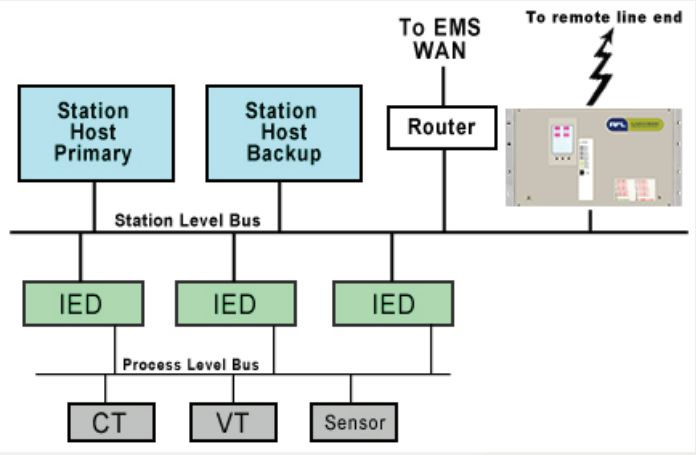
- Selectable FSK or ON/OFF operation
- Transmit frequency 30 to 500 kHz
- Programmable receive bandwidth and frequency shift
- Adjustable logic timers
- Unblock, blocking, permissive, transfer trip or phase comparison applications

Power Line Carrier features include:

- Channel monitoring
- Built-in check-back function; set for periodic check and/or remotely activated
- Extensive Sequence of Event Reporting
- Local or remote interrogation
- Built-in reflected power measurement

Ethernet Tripping Module (IEC 61850 compliant)

The GARD 8000 System can be provided with an Ethernet Tripping Module. IEC 61850 substation automation provides a LAN (Local Area Network) in the substation where trip messages are passed between the devices via GOOSE messages on a TCP/IP network.



Protection (continued)

The GOOSE is routed to perform trip functions of circuit breakers but a shortcoming with the network is that there is no easy means to transfer a GOOSE message to a remote location if the Ethernet network does not encompass the two substations. The GARD 8000 Ethernet tripping module solves this dilemma, by retrieving GOOSE messages from the LAN and transporting them over any of its communica-tion interfaces. The communication interface can be of any type supported by GARD 8000; digital, fiber, audio-tone and/or PLC.

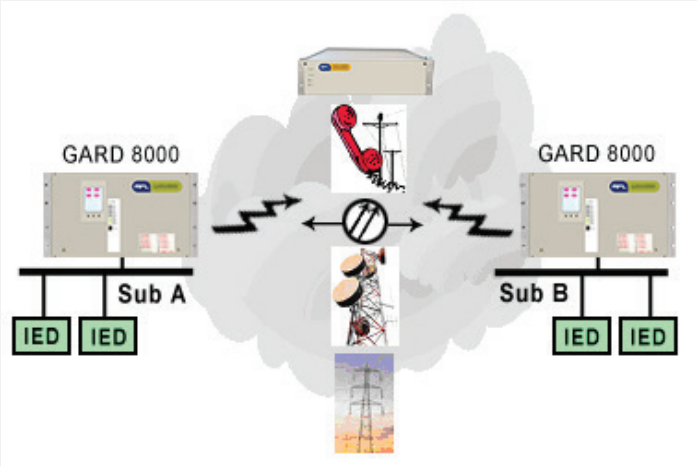


Figure 17. GARD 8000 teleprotection between two IEC 61850 substations

The GARD 8000 provides the link between two IEC 61850 substations over any communication media. The sending GARD 8000 retrieves GOOSE messages from the substation LAN, puts it on a communication link to a remote GARD 8000, that puts it on its substation LAN.

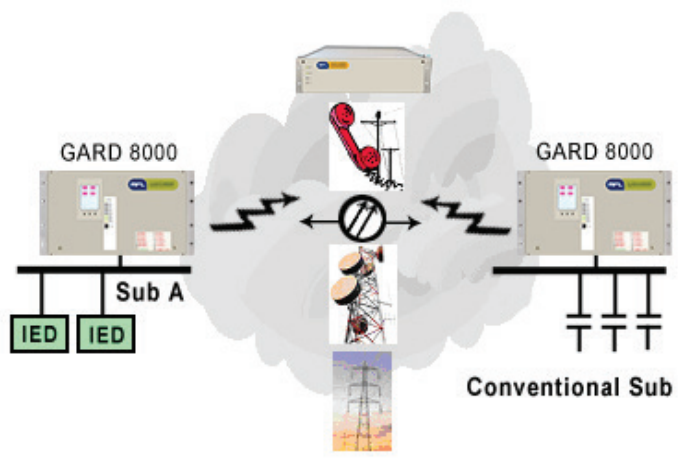
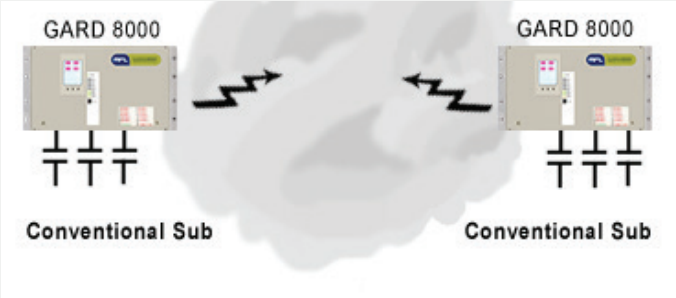


Figure 18. GARD 8000 Teleprotection between an IEC 61850 substation and a conventional substation

Generally, a new IEC 61850 substation needs to interact with a conventional substation at remote line ends. In this case, the GARD 8000 retrieves GOOSE messages for transfer trip or pilot relaying operations from the IEC 61850 substation LAN, transports them over any communication link and the remote, receiving GARD 8000 performs normal teleprotection operations such as tripping of breakers and pilot relaying signaling.

In addition, in case pilot relaying and teleprotection need to be performed over an Ethernet network between two conventional substations, a GARD 8000 at each line end can send GOOSE messages over the network for intertripping.



High Capacity Status Transfer Module

The GARD 8000 standard Teleprotection System supports up to eight high-speed functions in one 64 kbps channel. For telemetry applications, there is often a need to transport a higher number of status points, but transmission time is less critical than for teleprotection signaling. To complement the teleprotection systems, a high capacity status module is available. This module supports up to 96 status bits over a 64 kbps channel. End-to-end delay is 7-12 ms, depending on the security count used.

The high capacity status transfer module can be added as an optional front mounted module, or be supplied instead of the standard teleprotection system on the Base TPS/Display board.

Examples of GARD 8000 System Configurations

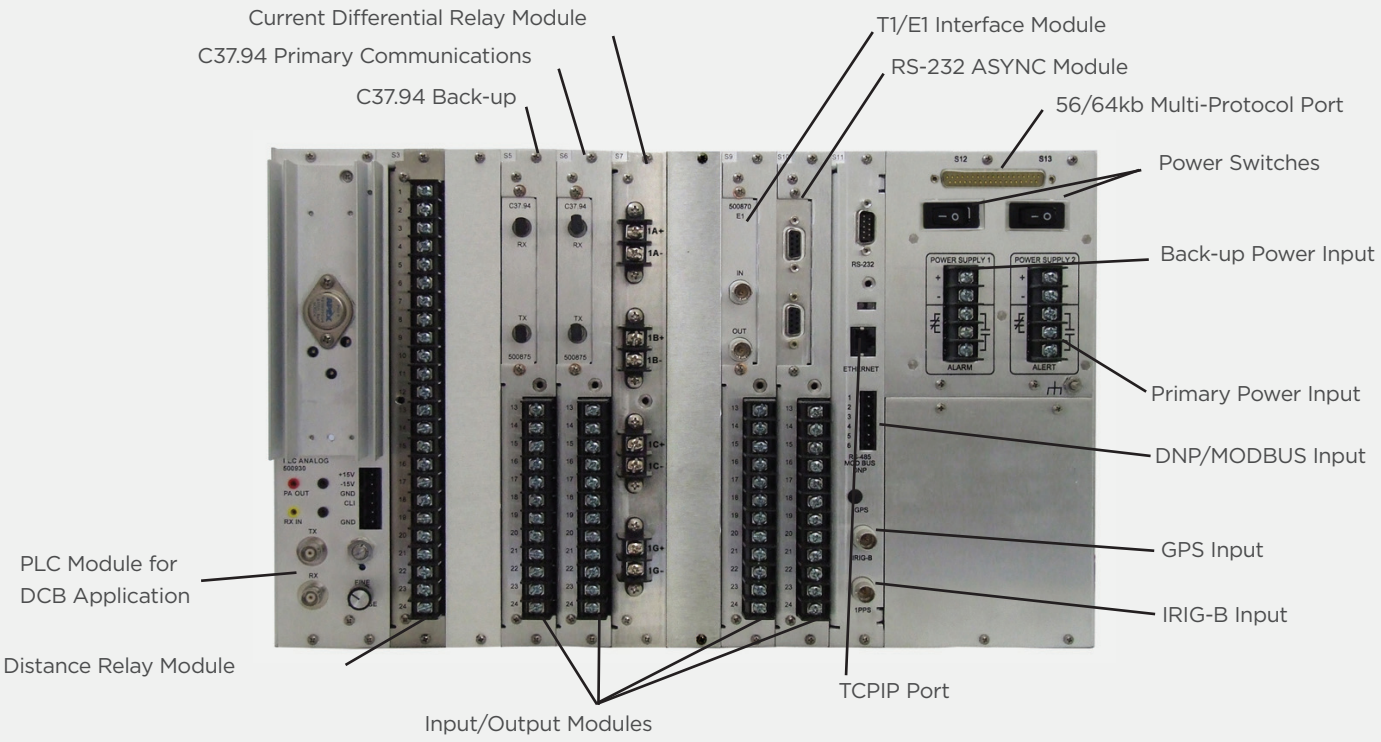


Figure 9. Rear View 6U GARD 8000 with Distance Module with Powerline Carrier Interface and Current Differential Relay with Primary and Back-Up Communications

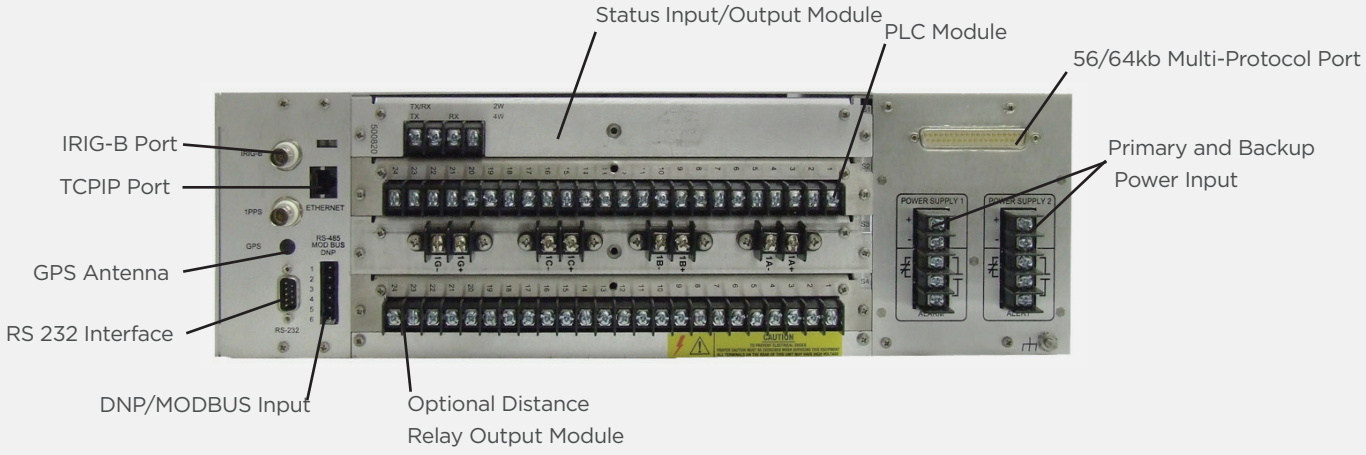


Figure 10. Rear View 3U GARD 8000 with PLC Module, Distance Relay, and Input/Output Module

Dimensions

GARD 8000
Single Function PLC
3U System Dimensions

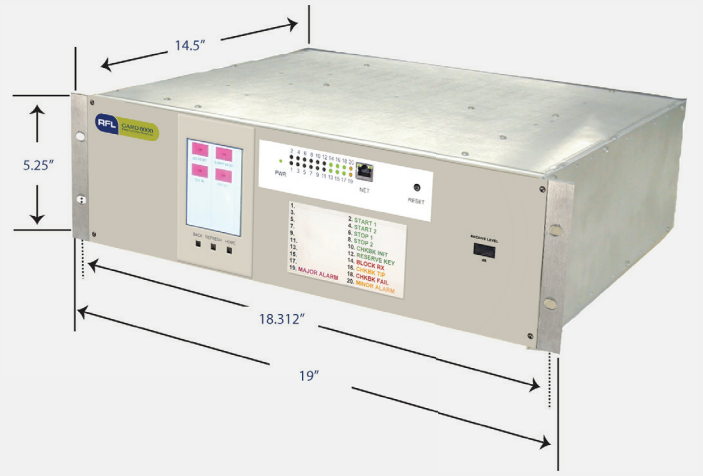


Figure 11. Rack or Cabinet Mounting (3U)

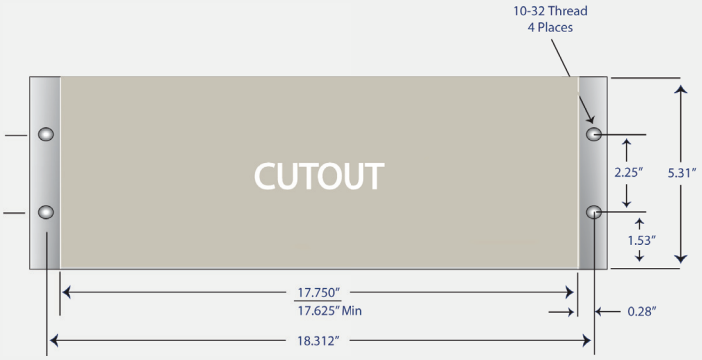


Figure 12. Panel Mounting (3U)

6U System Dimensions

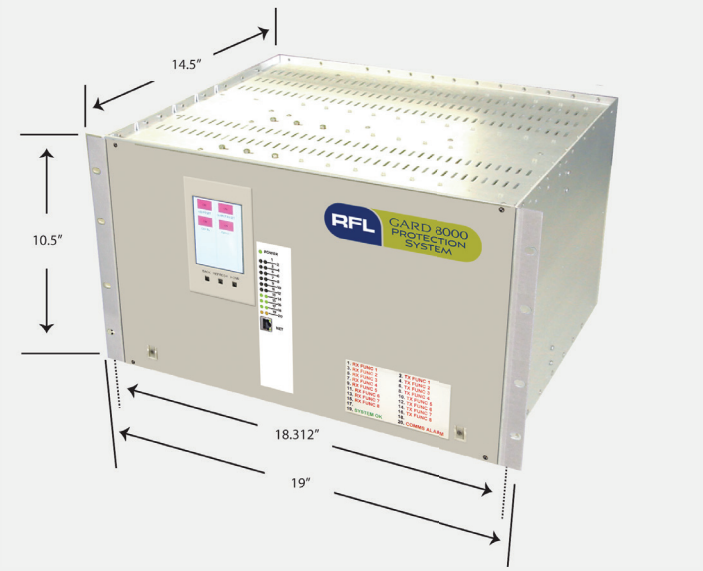


Figure 13. Rack or cabinet Mounting (6U)

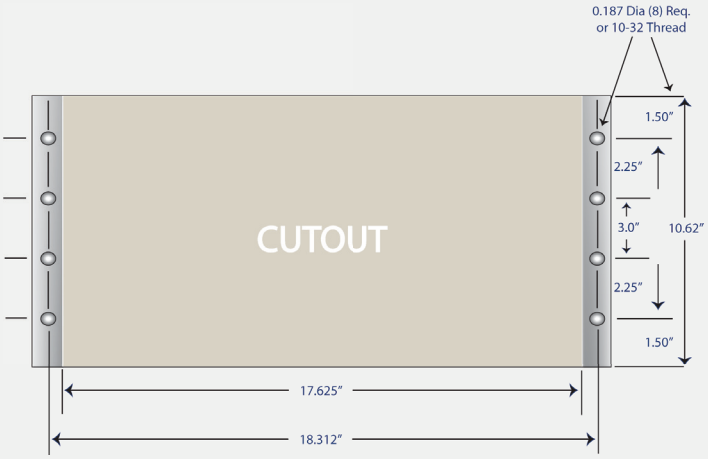


Figure 14. Panel Mounting (6U)

Notes

Notes

RFL Electronics Inc.
353 Powerville Road
Boonton, NJ 07005, USA

Tel: 973.334.3100
Fax:973.334.3863
www.rflelect.com